

**WHAT IS CLAIMED IS:**

1. A quantum ridge product comprising a substrate having a plurality of substantially parallel quantum ridges on a surface thereof, each pair of adjacent quantum ridges of said plurality quantum ridges having a pitch of 5.4 to 600Å and being separated by a groove having a width of 6 to 597Å and a depth of 4 to 30,000Å.
2. The product of claim 1, wherein each said adjacent pair of quantum ridges is separated by a groove having a width of 6 to 51Å.
3. The product of claim 2, wherein each said adjacent pair of said plurality of quantum ridges having a pitch of 9.4 to 54.
4. The product of claim 1, wherein said at least one groove has a width of 6 to 51Å and a depth of 4 to 3000Å.
5. The product of claim 1, wherein said substrate comprises a semiconductor material.
6. The product of claim 1, wherein said substrate comprises silicon.
7. The product of claim 1, wherein said substrate comprises a group III-V semiconductor.

8. The product of claim 1, wherein said substrate comprises GaAs.
9. The product of claim 1, wherein said substrate has a (1 1 4) surface structure.
10. The product of claim 1, wherein said substrate has a (5 5 12) surface structure.
11. The product of claim 1, further comprising an organic molecule located in at least one of said grooves.
12. The product of claim 1, further comprising a fullerene tube located in at least one of said grooves.
13. The product of claim 1, further comprising at least one fullerene ball at least partially filling at least one of said grooves.
14. The product of claim 1, wherein said at least one quantum ridge is located in a depression of a substrate.
15. The product of claim 1, wherein said at least one quantum ridge is located within a convex region of a substrate.

16. The product of claim 1, wherein said at least one quantum ridge comprises a vapor liquid solid.
17. The product of claim 1, wherein alternating ridges of said plurality of quantum ridges have crooked edges.
18. A quantum ridge product comprising: a substrate having a plurality of substantially parallel quantum ridges on a surface thereof, each pair of adjacent quantum ridges of said plurality of quantum ridges having a pitch of  $5.4\text{\AA}$  to  $600\text{\AA}$  and being separated by a groove having a width of  $6\text{\AA}$  to  $597\text{\AA}$ , at least one of said quantum ridges having a quantum wire supported on top of said at least one quantum ridge and extending in a direction along the length of said quantum ridge, said quantum wire comprising a conductive material having a width of  $3\text{\AA}$  to  $594\text{\AA}$ .
19. The product of claim 18, wherein said quantum wire has a thickness of about  $6\text{\AA}$  to  $30,000\text{\AA}$ .
20. The product of claim 18, wherein each of said grooves has a depth of  $4\text{\AA}$  to  $30,000\text{\AA}$ .
21. The product of claim 18, wherein said at least one groove has a width of  $6\text{\AA}$  to  $51\text{\AA}$  and a depth of  $4\text{\AA}$  to  $3,00\text{\AA}$ .

22. The product of claim 18, wherein each said adjacent pair of said plurality of quantum ridges having a pitch of 9.4 to 54Å.

23. The product of claim 18, wherein said at least one quantum ridge having a quantum wire supported thereon comprises at least two quantum ridges and each of said quantum ridges has a respective quantum wire supported on top thereof and extending in a direction along the length thereof, each of said respective quantum wires having a width of 3Å to 594Å.

24. The product of claim 18, wherein said substrate comprises a semiconductor material.

25. The product of claim 18, wherein said substrate comprises silicon.

26. The product of claim 18, wherein said substrate comprises a group III-V semiconductor.

27. The product of claim 18, wherein said substrate comprises GaAs.

28. The product of claim 18, wherein said quantum wire comprises metal.

29. The product of claim 18, further comprising a larger band gap material which covers at least a portion of said quantum wire, said larger band gap material having larger band gap than said quantum wire.
30. The product of claim 29, wherein said larger band gap material comprises silicon dioxide.
31. The product of claim 29, wherein said larger band gap material comprises silicon nitride.
32. The product of claim 29, wherein said larger band gap material comprises diamond-like carbon.
33. The product of claim 18, wherein said substrate has a (1 1 4) surface structure.
34. The product of claim 18, wherein said substrate has a (5 5 12) surface structure.
35. The product of claim 18, wherein said plurality of quantum ridges are located in a depression of a substrate.
36. The product of claim 18, wherein said plurality of quantum ridges are located within a convex region of a substrate.

37. The product of claim 18, wherein said plurality of quantum ridges comprise a vapor liquid solid.

38. The product of claim 18, wherein alternating ridges of said plurality of quantum ridges have crooked edges.

39. A quantum tip product comprising a substrate having a plurality of quantum tips on a surface thereof, each of said plurality of quantum tips being separated from adjacent quantum tips by grooves, each of said grooves having a width of 6 to 597Å and a depth of 4 to 30,000Å.

40. The product of claim 39, wherein each of said grooves has a width of 6Å to 51Å.

41. The product of claim 39, wherein each of said grooves has a width of 6Å to 51Å and a depth of 4Å to 3,000Å.

42. The product of claim 39, wherein each of said quantum tips is separated from a first set of two of said adjacent quantum tips in a first direction by a first pair of substantially parallel grooves and is separated from a second set of two of said adjacent quantum tips in a second direction by a second pair of substantially parallel grooves, said first and said second direction being perpendicular to each other.

43. The product of claim 42, each said adjacent pair of said plurality of quantum tips has a pitch of  $5.4\text{\AA}$  to  $600\text{\AA}$  in at least one direction.
44. The product of claim 42, wherein each said adjacent pair of said plurality of quantum tips has a pitch of 9.4 to 54 in at least one direction.
45. The product of claim 39, wherein said substrate comprises a semiconductor material.
46. The product of claim 39, wherein said substrate comprises silicon.
47. The product of claim 39, wherein said substrate comprises a group III-V semiconductor.
48. The product of claim 39, wherein said substrate comprises GaAs.
49. The product of claim 39, wherein said substrate has a (1 1 4) surface structure.
50. The product of claim 39, wherein said substrate has a (5 5 12) surface structure.
51. The product of claim 39, further comprising a fullerene tube located in at least one of said grooves.

52. The product of claim 39, further comprising a plurality of fullerene balls at least partially filling at least one of said grooves.

53. The product of claim 39, wherein said plurality of quantum tips are located in a depression of a substrate.

54. The product of claim 39, wherein said plurality of quantum tips are located within a convex region of a substrate.

55. The product of claim 39, wherein said plurality of quantum tips are comprised of a vapor liquid solid.

56. The product of claim 39, wherein alternating tips of said plurality of quantum tips have crooked edges in at least one direction.

57. A quantum tip product comprising a substrate having a plurality of quantum tips on a surface thereof, each of said plurality of quantum tips being separated from adjacent quantum tips by grooves, each of said grooves having a width of  $6\text{\AA}$  to  $597\text{\AA}$ , at least one of said quantum tips having a quantum dot supported on top of said at least one quantum tip said quantum dot comprising a conductive material having a width of  $3\text{\AA}$  to  $594\text{\AA}$ .



58. The product of claim 57, wherein said quantum dot has a thickness of about 6Å to 30,000Å.

59. The product of claim 57, wherein each of said grooves has a depth of 4Å to 30,000Å.

60. The product of claim 57, wherein each of said grooves has a width of 6Å to 51Å.

61. The product of claim 57, wherein each of said grooves has a width of 6Å to 51Å and a depth of 4Å to 5100Å.

62. The product of claim 57, wherein each of said quantum tips is separated from a first set of two of said adjacent quantum tips in a first direction by a first pair of substantially parallel grooves and is separated from a second set of two of said adjacent quantum tips in a second direction by a second pair of substantially parallel grooves, said first and said second direction being perpendicular to each other.

63. The product of claim 62, each said adjacent pair of said plurality of quantum tips has a pitch of 5.4Å to 600Å in at least one direction.

64. The product of claim 62, wherein each said adjacent pair of said plurality of quantum tips has a pitch of 9.4Å to 54Å in at least one direction.

65. The product of claim 57, wherein said substrate comprises a semiconductor material.
66. The product of claim 57, wherein said substrate comprises silicon.
67. The product of claim 57, wherein said substrate comprises a group III-V semiconductor.
68. The product of claim 57, wherein said substrate comprises GaAs.
69. The product of claim 57, wherein said quantum dot comprises metal.
70. The product of claim 57, further comprising a larger band gap material which covers at least a portion of said quantum dot, said larger band gap material having larger band gap than said quantum wire.
71. The product of claim 70, wherein said larger band gap material comprises silicon dioxide.
72. The product of claim 70, wherein said larger band gap material comprises silicon nitride.

73. The product of claim 70, wherein said larger band gap material comprises diamond-like carbon.

74. The product of claim 57, wherein said substrate has a (1 1 4) surface structure.

75. The product of claim 57, wherein said substrate has a (5 5 12) surface structure.

76. The product of claim 57, wherein said plurality of quantum tips are located in a depression of a substrate.

77. The product of claim 57, wherein said plurality of quantum tips are located within a convex region of a substrate.

78. The product of claim 57, wherein said plurality of quantum tips are comprised of a vapor liquid solid.

79. The product of claim 57, wherein alternating ridges of said plurality of quantum ridges have crooked edges.

80. A method for making a quantum structure product comprising the steps of:  
providing a first substrate having a (1 1 X) surface structure and including a plurality of substantially parallel quantum ridges and grooves on a surface thereof, the grooves having a width of 6Å to 597Å and separating adjacent quantum ridges; and

coating the first substrate with a metal to form at least one quantum wire on at least one of the quantum ridges, the at least one quantum wire having a width of 3Å to 594Å.

81. The method of claim 80, wherein said substrate is formed by the following steps:  
heating pre-substrate having a (1 1 X) surface structure to remove surface oxides; and

cooling the pre-substrate to about -20°C to 900°C to form the first substrate.

82. The method of claim 81, wherein said heating step comprises heating said pre-substrate using a beam-expanded laser.

83. The method of claim 80, wherein said first substrate is formed by the following steps:

heating a pre-substrate comprising Si having a (1 1 X) surface structure at a pressure of  $10^{-10}$  torr and about 1150° C to remove surface oxides; and

cooling the pre-substrate to about 1°K to 253°K to form the first substrate.

84. The method of claim 80, wherein the quantum wire comprises a conductive material.

85. The method of claim 80, further comprising at least partially covering the quantum wire with a larger band gap material, the larger band gap material having larger band gap than said quantum wire.

86. The method of claim 85, wherein said larger band gap material comprises silicon dioxide.

87. The method of claim 85, wherein said larger band gap material comprises silicon nitride.

88. The method of claim 85, wherein said larger band gap material comprises diamond-like carbon.

89. The method of claim 80, wherein the at least one quantum wire is deposited on the at least one quantum ridge by oblique evaporation of quantum wire material onto the first substrate at an angle of  $1^{\circ}$  to  $30^{\circ}$ .

90. The method of claim 80, wherein the quantum wire comprises a material resistant to an etching solution and said method further comprises the step of etching the grooves on the first substrate to form grooves having a depth of  $4\text{\AA}$  to  $3,000\text{\AA}$ .

91. The method of claim 80, further comprising the step of removing the quantum wires.

92. The method of claim 80, further comprising the step of inactivating portions of the at least one quantum wire to form quantum dots.

93. The method of claim 92, further comprising the step of at least partially covering the quantum dots with a larger band gap material, the larger band gap material having larger band gap than said quantum wire.

94. The method of claim 93, wherein said larger band gap material comprises silicon dioxide.

95. The method of claim 93, wherein said larger band gap material comprises silicon nitride.

96. The method of claim 93, wherein said larger band gap material comprises diamond-like carbon.

97. The method of claim 80, wherein portions of the at least one quantum wire are removed by pressing second substrate having a plurality of substantially parallel quantum ridges on the surface thereof against the first substrate.

98. The method of claim 97, wherein the second substrate is pressed against the first substrate so that the quantum ridges on the second substrate are oriented at a right angle to the quantum ridges on the second substrate.

99. The method of claim 80, further comprising the step of inactivating portions of the at least one quantum wire to form quantum dots.

100. The method of claim 99, wherein portions of the at least one quantum wire are removed by pressing second substrate having a plurality of substantially parallel quantum ridges on the surface thereof against the first substrate.

101. The method of claim 100, wherein the second substrate is pressed against the first substrate so that the quantum ridges on the second substrate are oriented at a right angles to the quantum ridges on the second substrate.

102. The method of claim 99, wherein the at least one quantum wire comprises a conductive material.

103. The method of claim 99, further comprising the step of at least partially covering the quantum dots with a larger band gap material, the larger band gap material having larger band gap than said quantum dots.

104. The product of claim 103, wherein said larger band gap material comprises silicon dioxide.

105. The product of claim 104, wherein said larger band gap material comprises silicon nitride.

106. The product of claim 104, wherein said larger band gap material comprises diamond-like carbon.

107. A quantum ridge product comprising two quantum ridge substrates bonded to each other, each of said substrates having a plurality of substantially parallel quantum ridges on a surface thereof, each pair of adjacent quantum ridges of said plurality quantum ridge having a pitch of  $5.4\text{\AA}$  to  $600\text{\AA}$  and being separated by a groove having a width of  $6\text{\AA}$  to  $597\text{\AA}$  and a depth of  $4\text{\AA}$  to  $30,000\text{\AA}$ , said quantum ridge substrates being bonded together at the quantum ridge surface of each substrate.

108. The quantum ridge product of claim 107, wherein said product includes quantum dots supported on said ridges of at least one of said substrates.

109. The quantum ridge product of claim 107, wherein said quantum ridges on one of said two substrates are substantially parallel to the quantum ridges on the second of said two substrates.



110. The quantum ridge product of claim 107, wherein said quantum ridges on one of said two substrates are substantially perpendicular to the quantum ridges on a second said two substrates.

111. A quantum ridge product comprising: a substrate having a plurality of substantially parallel quantum ridges on a surface thereof, each pair of adjacent quantum ridges of said plurality quantum ridge having a pitch of  $5.4\text{\AA}$  to  $600\text{\AA}$  and being separated by a groove having a width of  $6\text{\AA}$  to  $597\text{\AA}$ , at least one of said quantum ridges having a quantum dot supported on top of said at least one quantum ridge, said quantum dot comprising a conductive material having a width in at least one direction of  $3\text{\AA}$  to  $594\text{\AA}$ .

112. The product of claim 111, wherein said quantum dot has a thickness of about  $6\text{\AA}$  to  $30,000\text{\AA}$

113. The product of claim 111, wherein each of said grooves has a depth of  $4\text{\AA}$  to  $30,000\text{\AA}$ .

114. The product of claim 111, wherein said at least one groove has a width of  $6\text{\AA}$  to  $51\text{\AA}$  and a depth of  $4\text{\AA}$  to  $3,000\text{\AA}$ .

115. The product of claim 111, wherein said at least one quantum ridge having a quantum wire supported thereon comprises at least two quantum ridges and each of said

quantum ridges has a respective quantum wire supported on top thereof and extending in a direction along the length thereof, each of said respective quantum wires having a width of 3Å to 594Å.

116. The product of claim 115, wherein each of said grooves has a depth of 4Å to 30,000Å.

117. The product of claim 111, wherein each said adjacent pair of said plurality of quantum ridges has a pitch of 9.4 to 54.

118. The product of claim 111, wherein said substrate comprises a semiconductor material.

119. The product of claim 111, wherein said substrate comprises silicon.

120. The product of claim 111, wherein said substrate comprises a group III-V semiconductor.

121. The product of claim 111, wherein said substrate comprises GaAs.

122. The product of claim 111, wherein said quantum wire comprises metal.

123. The product of claim 111, further comprising a larger band gap material which covers at least a portion of said quantum dot, said larger band gap material having larger band gap than said quantum wire.

124. The product of claim 123, wherein said larger band gap material comprises silicon dioxide.

125. The product of claim 123, wherein said larger band gap material comprises silicon nitride.

126. The product of claim 123, wherein said larger band gap material comprises diamond-like carbon.

127. The product of claim 111, wherein said substrate has a (1 1 4) surface structure.

128. The product of claim 111, wherein said substrate has a (5 5 12) surface structure.

129. The product of claim 111, wherein said plurality of quantum ridges are located in a depression of a substrate.

130. The product of claim 111, wherein said plurality of quantum ridges are located within a convex region of a substrate.

131. The product of claim 111, wherein said plurality of quantum ridges are comprised of a vapor liquid solid.

132. A quantum ridge product comprising a substrate having a quantum ridge on a surface thereof, said quantum ridge having a width of  $3\text{\AA}$  to  $47\text{\AA}$  and a height of  $4\text{\AA}$  to  $3,000\text{\AA}$ .

133. The quantum ridge product of claim 132, further comprising a quantum wire supported on said quantum ridge.

134. The quantum ridge product of claim 132, further comprising at least one quantum dot supported on said quantum ridge.

135. The quantum ridge product of claim 132, further comprising a plurality of quantum dots supported on said quantum ridge.

136. A quantum tip product comprising a substrate having a quantum tip on a surface thereof, said quantum tip having a width in at least one direction of  $3\text{\AA}$  to  $47\text{\AA}$  and a height of  $4\text{\AA}$  to  $3,000\text{\AA}$ .

137. The quantum tip product of claim 136, further comprising a quantum dot supported on said quantum tip.

138. A quantum structure product comprising a substrate including a groove having a width of  $6\text{\AA}$  to  $597\text{\AA}$  and a depth of  $4\text{\AA}$  to  $30,000\text{\AA}$ .

139. The product of claim 138, wherein said groove has a width of  $6\text{\AA}$  to  $51\text{\AA}$ .